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WORLD

WIDE

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TRANSLATIONS ON ENVIRONMENTAL QUALITY

(FOUO 1/79)

U. S. JOINT PUBLICATIONS RESEARCH SERVICE

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19 January 1979

TRANSLATIONS ON ENVIRONMENTAL QUALITY

(FOUO 1/79)

CONTENTS PAGE

JAPAN

FEW PLACES MEET NOISE POLLUTION STANDARDS

Tokyo THE JAPAN TIMES in English 23 Dec 78 p 2

[Text]

The Environment Agency announced Friday that in fiscal 1977 of all noise pollution monitoring points, only 17.6 percent recorded noise levels within government-set environmental standards.

The agency said the figure could not be compared with that for fiscal 1976 because the number of monitoring points were different for the two years.

In fiscal 1976, 21.3 percent of the monitoring points met environmental standards.

In the latest survey, noise levels were measured at 2,802 points in the morning, in the afternoon, in the evening and at night.

Of them, 494 monitoring points or 17.6 percent met environmental standards.

In fiscal 1976, of the 2,263 monitoring points, 481 or 21.3 percent met environmental standards.

Thus the percentage of monitoring points meeting the environmental standards went down by 3.7 percent during the last fiscal year.

When auto traffic noise exceeds environmental standards and impairs living environments, prefectural governors are authorized to ask local public safety commissions for traffic restrictions.

In fiscal 1977, excessive traffic noise was recorded at 626 or 22.3 percent of the monitoring points as compared with 20.3 percent during the previous year.

By time, 37 percent of the total number of monitoring points met environmental standards in the morning, 31.2 percent in the afternoon, 31.2 percent in the evening, and 47.9 percent at night.

The noisiest three roads were Loop No. 7 in Tokyo, Route No. 1 in and around Okazaki, Aichi Prefecture, and Route No. 43 in Aishiya, Amagasaki, Nishinomiya, and Kobe, Hyogo Prefecture.

The Construction Ministry is to spend a total of ¥693.1 billion in building green belts and noise buffer walls to reduce noise near roads during the 8th road improvement program beginning in fiscal 1978.

As for measures against noise sources, new automobiles will be required to reduce their noise output by one to five phons from present levels beginning Jan. 1.

However, it takes about five to six years for new cars to replace old cars. Thus it will be some years later before the noise environmental standards will be met at most monitoring points. This does not however take into account the expected increase in traffic volume.

CSO: 5000

JAPAN

BRIEFS

CYANIDE FOULS OSAKA RIVERS--Ibaraki, Osaka--Workers at the Kobe Steel company's Ibaraki plant here worked desperately Tuesday trying to collect hundreds of fish that died after a metal-plating tank overflowed and discharged cyanide into a nearby river the previous day. According to investigators, the runoff, later found to have been caused by a clogged drain pipe, was discovered about 3 p.m. Monday when workers noted that the contents of a tank next to the metal-plating one were abnormally discolored. Plant operations were stopped after water collected from a drainage outlet at the Taisho River was found to have a cyanide count of 66 parts per million versus an official environmental standard of 1 ppm. Large numbers of fish in the Ai and Kanzaki rivers downstream of the Taisho River were also found floating dead in Suita City and residents were warned not to eat any fish taken from the rivers. [Text] [Tokyo MAINICHI DAILY NEWS in English 20 Dec 78 p 12]

CSO: 5000

WEST GERMANY

ENVIRONMENTAL DAMAGE FROM CONVENTIONAL, NUCLEAR POWER PLANTS COMPARED

Duesseldorf ATOMWIRTSCHAFT-ATOMTECHNIK in German Nov 78, pp 524-532

[Article by W. Schikarski: "Environmental Effects of Conventional and Nuclear Energy Production"]

[Text] If we compare the atmospheric pollution burden arising from coal and nuclear power plants, then in a calculation of relative pollution burden based on an annual pollution balance there results a ratio of about 1:100 in favor of nuclear energy if we use a cell model. If we consider the basic substance of air pollution from coal and heating oil power plants to be SO_2, then the measured immission values are 10 times below the dosage for immission burden for which health hazards are known to occur; but the dosage burden in the environment of nuclear power plants is 10,000 times below this value. Waste heat occurs for all types of energy conversion regardless of the energy carrier. The amount of primary waste heat from power plants to the total amount of waste heat is only about 20 percent.

1. Introduction

Even though the discussion of environmental effects of present energy conversion processes will be discussed below, it is useful to point up again what we mean by environmental effects. Environmental protection is understood differently by various groups. For instance, one may mean protection of nature and another may mean the protection of the landscape and yet another may mean protection of the biosphere in general. In the following discussion, environmental protection shall be understood to mean protection of the human living area which will naturally include his foodstuffs, his air, his drinking water. This is not identical with the concepts mentioned above, there is even somewhat of a conflict.

DIRECT environmental effects due to energy conversion processes occur in three basic ways:

--through pollutants which act on the human organism through the air, water, food etc;

--by changing physical, chemical or biological environmental parameters (e.g., waste heat);

--noise.

Let us ignore the last point here since it only plays a role in energy conversion by the automobile.

INDIRECT environmental effects due to energy conversion processes have been little studied from a quantitative viewpoint. Such viewpoints are the reduction in availability of resources, the increase in social costs, the reduction in the quality of life which is certainly a very difficult parameter to quantify. Emphasis below shall be placed on the direct environmental effects of energy conversion in the FRG and a discussion of the present status and a medium-term future outlook will be discussed.

In addition to local and regional effects of pollutants and waste heat, the global aspects shall be discussed separately if necessary. Before the year 2000, regional environmental effects will be of greater significance.

2. Pollutants from Conventional Energy Conversion

2.1 Emissions

In the generation, conversion, transportation, storage and final consumption of energy carriers, emissions occur which are polluting to various degrees. The most important air-carried pollutants are:

--sulfur oxides (especially SO_2);
--hydrocarbons;
--nitrogen oxides;
--carbon monoxide;
--fluorine and chlorine compounds;
--dust (which can contain heavy metals).

In addition, carbon dioxide and water vapor are emitted which are insignificant from a toxicological point of view, but they do affect the thermal balance of the atmosphere. The named pollutants generally occur during combustion of the primary energy carrier: bituminous coal, brown coal, oil and natural gas. Emissions occurring through generation (pumping), transport and storage are of medium importance in the FRG (Table 1). Several of these pollutant emissions are naturally proportional to the

consumption of the particular energy carrier. They have increased since the reference year 1972 (an example is gasoline transport). Other pollutant emissions have tended to diminish (for example, because of decreasing production of pressed coal). We will not discuss the trends of individual pollutants in detail; these are presented elsewhere,[1] it is important to know the magnitude of emissions for the generation, transport and storage of fossil energy carriers.

Table 1. Pollutant Emissions during Generation, Processing and Transport of Energy Carriers

1 Schadstoff	SO_2	2 Staub	NO_x	$C_m H_n$	CO
3 Emissionen [t/a]					10
4 Kokserzeugung	$3{,}0 \cdot 10^4$	$1{,}9 \cdot 10^4$	–	–	keine
5 Brikettherstellung	$6{,}1 \cdot 10^3$	$1{,}0 \cdot 10^4$	$5{,}7 \cdot 10^3$	–	Daten
6 Raffinerien	$2{,}6 \cdot 10^5$	–	–	$1{,}2 \cdot 10^5$	verfügbar
7 Erdöl/Erdgasgewinnung und -Transport		9 keine Daten verfügbar			
8 Benzintransport und -Lagerung	–	–	–	$\sim 4 \cdot 10^4$	

Key:
1. Pollutant
2. Dust
3. Emissions (tons/year)
4. Coke generation
5. Pressed coal production
6. Refineries
7. Petroleum/natural gas production and transport
8. Gasoline transport and storage
9. No data available
10. No data available

Table 2. Pollutant Emissions through Fuel Consumptions

1 Schadstoff	SO_2	7 Staub	NO_x	$C_m H_n$	CO
2 Emissionen [t/a]					
3 Industrie	$1{,}1 \cdot 10^6$	$1{,}0 \cdot 10^5$	$4{,}0 \cdot 10^5$	$4{,}0 \cdot 10^4$	$8{,}0 \cdot 10^4$
4 Haushalt & Kleinverbraucher	$7{,}2 \cdot 10^5$	$1{,}8 \cdot 10^5$	$1{,}3 \cdot 10^5$	$7{,}2 \cdot 10^4$	$7{,}6 \cdot 10^5$
5 Straßenverkehr	$4{,}8 \cdot 10^4$	$9{,}0 \cdot 10^4$	$2{,}5 \cdot 10^5$	$2{,}5 \cdot 10^5$	$6{,}0 \cdot 10^5$
6 Summe	$1{,}9 \cdot 10^6$	$3{,}7 \cdot 10^5$	$7{,}8 \cdot 10^5$	$3{,}6 \cdot 10^5$	$6{,}8 \cdot 10^5$

Key:
1. Pollutant
2. Emissions (ton/year)
3. Industry
4. Domestic and small consumers
5. Highway traffic
6. Total
7. Dust

Table 3. Pollutant Emissions due to Electricity Generation (Fossil Fuels)

1 Schadstoff	SO_2	4 Staub	NO_x	$C_m H_n$	CO
2 Emissionen [t/a] 3 Fossil-beheizte Kraftwerke	$1{,}75 \cdot 10^6$	$2{,}5 \cdot 10^5$	$5{,}4 \cdot 10^5$	$1{,}0 \cdot 10^4$	$2{,}0 \cdot 10^4$

Key:
1. Pollutant
2. Emissions (tons/year)
3. Fossil fuel-burning power plants
4. Dust

Table 4. Total Pollutant Emissions from Energy Conversion by Fossil Fuels

1 Schadstoff	SO_2	2 Staub*)	NO_x	$C_m H_n$	CO
3 Emissionen [t/a]					
4 Gewinnung, Transport, Lagerung	$3{,}0 \cdot 10^5$	$2{,}9 \cdot 10^4$	$6{,}0 \cdot 10^3$	$2{,}0 \cdot 10^5$	?
5 Endverbrauch	$1{,}9 \cdot 10^6$	$3{,}7 \cdot 10^5$	$7{,}8 \cdot 10^5$	$3{,}6 \cdot 10^5$	$6{,}8 \cdot 10^5$
6 Stromerzeugung	$1{,}7 \cdot 10^6$	$2{,}5 \cdot 10^5$	$5{,}4 \cdot 10^5$	$1{,}0 \cdot 10^4$	$2{,}0 \cdot 10^4$
7 Summe	$3{,}9 \cdot 10^6$	$6{,}5 \cdot 10^5$	$1{,}3 \cdot 10^6$	$5{,}7 \cdot 10^5$	$6{,}8 \cdot 10^5$

8 *) ohne Staubemissionen aus industriellen Prozessen

Key:
1. Pollutant
2. Dust
3. Emissions (ton/year)
4. Generation, transport, storage
5. Final consumption
6. Electricity generation
7. Total
8. Excluding dust emissions from industrial processes

Table 5. Relative Pollution due to Total Pollutant Emissions

1 Schadstoff	SO_2	2 Staub	NO_x	$C_m H_n$	CO
3 Relative Schadstoffbelastung bezogen auf die Immissionsgrenzwerte der TA-Luft von 1974	1,46	0,77	0,25	0,15	0,35

Key:
1. Pollutant
2. Dust
3. Relative environmental pollution based on the emission limits of the "Air" technical committee/established in 1974

Atmospheric pollutant emissions arising from final consumption of solid, liquid and gaseous fuels were clearly higher in the reference year in the areas of industry, households and small consumers as well as traffic (Table 2). Since primary energy use has changed only by a few percentage points, we assume that these figures are still generally valid today--even with regard to the existing uncertainties.

In the area of electricity generation from fossil fuels, pollution emissions were of comparable magnitude (Table 3). Since electricity consumption has continued to grow, pollutant emissions have also increased. Extrapolation of pollutant emissions from the reference year to the present does contain certain inaccuracies. These are caused by the fact that pollutant emissions are correlated not only to the growth in electricity consumption but also to the increase in specific emissions (new facilities basically emit fewer pollutants). The figures of Table 3 are based on average specific emissions over a broad spectrum of old and new power generation facilities. Thus, the increase in total pollutant emissions from fossil fuel power plants can be estimated. But overall, total pollutant emissions from electricity generation in the FRG have probably increased by only a few percent since 1972.

If we compile the three emission groups, then there results the following configuration (Table 4) for relative pollution: Total pollutant emissions from final consumption are approximately the same as those from electricity generation. Only for hydrocarbons and carbon monoxide do emissions from final fuel consumption exceed those from electricity generation by more than one order of magnitude. Here again, households and traffic are the most important contributors.

Pollutant emissions alone do not constitute a direct measure of environmental pollution since emission rates are not equal to pollution effect. We can use the concept of "relative pollutant effect." This concept assumes measured elevation distribution and residence times of atmospheric pollutants, whereby a hypothetical average pollutant concentration is calculated in a cylinder above the FRG. The relative pollution effect results as the ratio of average pollutant concentration to a maximum permissible emission concentration for various pollutants which was determined in a similar manner (e.g., based on pollutant limit values). The concept of relative pollution as a nondimensional quantity thus permits a comparison of environmental effects of different pollutants under consideration of emission and effect. Recently, this quantity has been called the environmental pollution index. In Table 5, we see the relative pollutant concentration of the reference pollutant for the entire energy conversion of the FRG. It is clear that the greatest contributors to atmospheric pollution are SO_2 and dust. A few supplemental comments are in order:

SO_2

The reduction in SO_2 emission must begin with both the consumer and electricity generation. Basically the final consumer can reduce emissions by dropping the sulfur content of light heating oil from 0.5 percent to 0.3 percent. Since final consumers emit pollutants at low emission altitudes in densely populated areas, this measure should receive priority.[2] A more extensive sulfur removal from light heating oil would be very difficult to realize technically. Since heating oil consumption by the final consumer will continue to increase at the expense of energy carriers of high specific emissions (like coke, pressed coal), it is assumed that SO_2 emissions by the final consumer will decrease over the medium term, but will hardly fall below 1.5 million tons of SO_2/year.[3]

The development of SO_2 emissions in electricity generation is significant. It is the expressed intention of the government to meet increasing electricity demands by coal-fired power plants. On the other hand, such power plants can only be approved when their emissions can be reduced from a present 3.75 kg SO_2/h MW to 2.75 kg SO_2/h MW of installed power. Further emission reductions to 1.25 kg SO_2/h MW are under discussion. The extent to which these specific emissions can be attained in practice will depend on several factors. For example, the reduction in SO_2 emission in flue gas in the FRG has still not been tested on a large scale. On the other hand, the necessary 80-percent removal of SO_2 in all flue gas can only be attained if the coal used does not exceed a certain sulfur content.

A pessimistic extrapolation of the SO_2 emissions from electricity generation must assume that for the short term, additional reduction in total SO_2 emissions from power plants cannot be expected unless SO_2 scrubbers are built into existing power plants (including oil-fired power plants). Overall, SO_2 emissions can increase for the medium term as a result of the intensified employment of coal, and on the other hand it can decrease, as a result of desulfurization measures on heating oil and through flue-gas scrubbing. Regional aspects, i.e., the question of power plant location, will be of great importance in this regard.

Table 6. SO_2 Emission Concentration from Air Sampling Stations of the Federal Environmental Office

1 Station	1970	1971	1972	1973	1974	1975	1976
2 Waldhof		30	28	20	18	18	21
3 Brotjacklriegel						9	11
4 Schauinsland	2	3	3	7	7	7	10
5 Deuselbach				17	13	15	20
6 Westerland				6	6	5	6
7 Mittelwert		16	16	13	11	11	14
8 (aus Werten)	(2)	(2)	(4)	(4)	(4)	(5)	(5)

9 (Jahresmittelwerte in µg SO_2/m^3)

Key:
1. Station
2. Waldhof
3. Brotjacklriegel
4. Schauinsland
5. Duselbach
6. Westerland
7. Average value
8. Total value
9. Annual average in µg SO_2/m^3

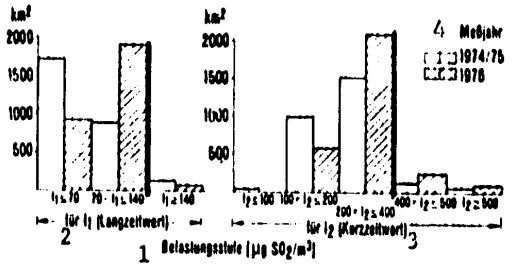

Figure 1: Surface Pollution and SO_2 Emission Pollution Stages for North Rhine-Westphalia

Key:
1. Pollution stage
2. for I_1
3. for I_2
4. Year of measurement

Dust

We should point up several aspects of dust emission from the combustion of fossil fuel. Dust emissions from the final consumer generally pass unfiltered into the atmosphere. Only power plants (and large industrial boilers) use dust scrubbers (usually electric filters) which achieve removal of between 99 and 99.8 percent. However, this removal is at present limited to coarse dust. Fine dust (aerosols) with a particle size less than 3 µm are generally not removed. However, this dust can be inhaled and is thus of greater toxicological importance than coarse dust.

Although I have already presented a relative pollution burden by dust from conversion of fossil fuels for the FRG, this value was related to the emission limit for harmless dusts as established by the "air" technical committee (1974). The sometimes highly toxic dust constituents like heavy metals, radioactive substances, etc. were not included. Depending on the level of these substances in the dust, such constituents can clearly increase the relative pollution effect of dust to the levels of SO_2. This is particularly true of dust emissions from bituminous coal power plants.[4]

But regardless of this, we must not forget that as a result of industrial processes other than energy conversion (we mean primarily the industrial areas of mining and construction as well as iron and steel) have about the same order of dust emissions.

In addition, these dust emissions--consisting primarily of fine dust--are masked by secondary aerosols. Secondary aerosols consist of airborne particles which arise from natural and anthropogenic gaseous emissions which only form aerosols in the atmosphere as a result of physical and chemical processing. We know, for example, that about 70 percent of initially

gaseous SO_2 in the atmosphere is converted there into sulphates. Global estimations of total dust emissions including secondary aerosols already exceed SO_2 emissions in total quantity.[5] This means that SO_2 has already been moved out of first place as an atmospheric pollutant.

2.2 Immissions

What is the situation regarding immissions? The immission situation today is well known in certain areas as a result of the operation of air pollution measuring network. Because of the so-called background stations of the Federal Environmental Office (Table 6), information from conjested areas regarding SO_2 varies, but is overall favorable. From the middle of the 1960's to the middle of the 1970's, SO_2 immissions have decreased on the average by a factor of two. Even in 1970 there was more than 600 km^2 in the FRG where the long-term immission limit value of 140 $\mu g/m^3$, set by the "air" technical committee in 1974, was not exceeded on an annual average. Today, this area is still 187 km^2.[3] Nevertheless, we must note that this represents regional averages which can be exceeded locally and which are not always based on the representative measured results so that larger errors (up to a maximum of 50 percent) are possible. Figure 1 is much more reliable; here, the distribution of the measured unit surfaces for the years 1974-75 and 1976 are plotted against the individual pollution stages for the air-monitoring network of Northrhine-Westphalia.[6] Here we see the immission limit values of the "air" technical committee of 140 $\mu g\ SO_2/m^3$ (long term) and 400 $\mu g\ SO_2/m^3$ (short term) are exceeded only in small subregions of the monitored area. On the other hand, the total SO_2 pollution has risen as we can see from the shift in distribution toward larger values.

The same thing can be said for immission pollution by total dust (coarse dust and fine dust). On the average, this pollution increased slightly from 1975 to 1976, however, the peak pollution has generally decreased. Dust levels were not exceeded if we use the following immission limits of 200 $\mu g/m^3$ (long term) and 400 $\mu g/m^3$ (short term) for total dust. However, as already mentioned, the contents of particular toxic dusts (metals, metal oxides, certain organic compounds) are not included.

In this regard, the present question of the immission pollution caused by individual, large bituminous coal power plants is important. Long-term immission measurements at modern power plants are not yet available. Such measurements might also be generally very difficult since the existing SO_2 prestress clearly exceeds the addition immission pollution at most locations. Using the best available (partly developed at the Karlsruhe nuclear research center) diffusion model, we calculate only 3 to 8 $\mu g\ SO_2/m^3$. for a 700 MWe power plant with a discharge of 730 g SO_2/sec (i.e., without reducing the SO_2 in the flue gas) as a yearly average (depending on location). The assumed tall smokestack of 250 m insures that the diffusion of immission concentration has a minor maximum between

3 and 8 km so that even at 15 km range, a medium immission of about 2 $\mu g\ SO_2/m^3$ exists. This illustrates the location difficulties which arise when pollutants are modified by dilution and when a large degree of prepollution by other emissions already exists.

Another problem which has recently been illustrated by several publications, is the "emission of radioactive substances from bituminous coal and brown coal (power plants)." This is in fact a problem attached only to these power plants since the radioactive components of petroleum and natural gas are several orders of magnitude smaller. In addition, the emissions are only relevant because the coal throughputs of power plants are very large. The content of natural radio nuclides (like radium, thorium, uranium, potassium-40 and others) fluctuates greatly so that previous calculations have yielded various pollution results. A Russian publication[7] postulates radiation stresses of more than 100 mrem/year (sum of all organ dosages) for a 1,000 MWe coal power plant, whereas Bonka et al[8] calculate about 70 mrem/yr and Kolb et al[9] calculate about 60 mrem/yr. Certainly, these calculated immissions would have to be detectable at the mentioned concentration. One study by Sennwitz[10] which attempted to determine artificial radium contamination in the environment of a large power plant showed that in fact a minor increase in the radium concentration of the soil occurred in the neighborhood of a coal/oil power plant at a level of 4 to 8 percent; this would correspond to an additional radiation stress of a few mrem/yr. In order to carefully answer the question of radiation from coal power plants, immission measurements of all relevant radionuclides should be performed soon and the results correlated to the radioactivity content of the coal and to the emitted dust. Such measurements would certainly provide information on aerosol behavior of the radioactive particles in the flue-gas vane, which is presently a generally unknown subject.

3. Pollutants from Nuclear Energy Generation

3.1 Immissions from Individual Plants

In the sphere of nuclear energy generation, the notable emitted radioactive pollutants come from nuclear power plants and reprocessing centers. The minor emissions from other plants in the nuclear fuel cycle (fuel element factories, waste depots) can be ignored for purposes of this study. In nuclear power plants, we are dealing primarily with the radioactive noble gases Xenon and (to a lesser extent) Krupton, whereby the position differs depending on the various isotopes of these gases from one plant to the next. Predominant isotopes are Xe-133 and Kr-85, and their emission depends on the air flow concept of the particular power plant. In addition, radioactive iodine I-131 should be mentioned; it leads to thyroid difficulties through the so-called pasture-cow-milk route.

Since nuclear power plants (in contrast to fossil-fuel power plants) are a closed system, emissions of the named radionuclides are small. These emissions occur only as a result of processes in connection with subpressure

conditions in the reactor building and with coolant purification. The official values of radiation stress in the environment of nuclear power plants due to airborne pollutants is illustrated in Table 8.[11]

Note the following: usually, such pollution data is compared with natural sources of radiation. As we know, we are subject to a natural radiation which is about 110 mrem/yr on the average. The numerical values shown in Table 7 represent pessimistic calculated maximum values which could only occur if the affected person remained constantly at the dangerous site in the neighborhood of an outdoor system. In reality, the stress values are thus clearly smaller. Only a smaller, more realistic value would be comparable to the "actual" natural radiation. This is particularly true for radiation stress due to I-131, where in addition, pessimistic transfer coefficients are included in the calculation. The figure published by BMI should thus be preceded by a "less than symbol."

The same thing can be said for radiation pollution from radioactive pollutants which are discharged with wastewater from nuclear power plants (Table 8).

The conditions of reprocessing centers are clearly different from those prevailing at nuclear power plants. Initially, we should point out that airborne pollutant emissions contain quite different radionuclides, namely, only long-lived isotopes since the radioactivity of short-lived nuclides in spent fuel drops to insignificant values between removal from the power plant and reprocessing. Secondly, we should distinguish between smaller centers of usually older construction and large centers at present in the building or planning stages. Whereas the radioactivity discharges from nuclear power plants are by no means proportional to the power output, for reprocessing centers, a linear connection exists between fuel input and radioactivity emissions. This means that large reprocessing centers handling more than 1,000 tons of uranium per year, require extensive exhaust gas purification systems. Since the design data for exhaust systems and real values measured in practice regarding pollutant emissions point up differences for nuclear power plants indicating that all values measured in practice are clearly smaller, then we expect the same result for the large reprocessing centers.

The most important radioactivity discharges from a quantity point of view are the radionuclides H-3, Kr-85, C-14 and I-129, whose emission factors for a large reprocessing center using, 1400 tons of uranium per year are shown in Table 9. The radiation burden from these nuclide emissions can be given as a function of location (for a given diffusion and retention factor.) It lies below the radiation protection regulation established value of 30 mrem/yr even in the immediate vicinity of an individual power plant.

Table 7: Radiation Exposure from Nuclear Power Plants due to Discharge of Radioactive Substances with Exhaust Air (1975)

1 Kernkraftwerk	2 Maximale[1]) Strahlenexposition (mrem/a) durch Ingestion				3 Mittlere Keimdrusen-exposition (mrem/a) der Bevölkerung über Gamma-Submersion im Umkreis von	
	4 Gamma-Submersion (Ganzkörperdosis)	5 Beta-Submersion (Hautdosis)	6 Jod-131 (Schilddrüse, Kleinkind)[2])	7 C-14 (Ganzkörper, Kleinkind)	8 0 bis 3 km	9 0 bis 20 km
10 Kahl	<0.2	<0.1	< 1	<0.01	<0.003	<0.001
11 Gundremmingen	<1	<0.2	<30	<0.04	<0.04	<0.004
12 Lingen	<5	<0.5	<80	<0.01	<0.2	<0.02
13 Obrigheim	<0.7	<2	<50	<0.4	<0.02	<0.003
14 Stade	<0.03	<0.03	< 3	<0.06	<0.001	<0.001
15 Würgassen	<0.06	<0.03	<0.6	<0.2	<0.002	<0.001
16 Biblis A	<0.02	<0.03	< 1	<0.1	<0.001	<0.001

17 [1]) berechnet für den ungünstigsten Aufpunkt
18 [2]) Annahme eines Milchverzehrs von 0.8 l pro Tag von einer Kuh, die während der Weidezeit dauernd am ungünstigsten Aufpunkt weidet, sowie Annahme, daß alles Jod in elementarer Form vorliegt

Key:

1. Nuclear power plant
2. Maximum radiation exposure (mrem/yr) through ingestion
3. Average gonad exposure (mrem/yr) of the population via gamma submersion in the environment
4. Gamma submersion (total body dosage)
5. Beta submersion (skin dosage)
6. Iodine-131 (thyroid, small child)
7. C-14 (total body, small child)
8. 0 - 3 km
9. 0 - 20 km
10. Kahl
11. Gundremmingen
12. Lingen
13. Obrigheim
14. Stade
15. Würgassen
16. Biblis A
17. Calculated for the least favorable field point.
18. Assumption of 0.8 liters per day milk output from 1 cow pasturing continuously at the least favorable field point and assume that all iodine is present in the elementary form.

Table 8. Radiation Exposure from Nuclear Power Plants due to Discharge of Radioactive Substances with Waste Water (1975).

1 Kernkraftwerk	2 Max. Strahlenexposition des Ganzkörpers (mrem/a) für Einzelpersonen über				7 Mittlere Strahlenexposition (mrem/a) der Bevölkerung (Ganzkörper) Gesamt[2])
	3 Trinkwasser	4 Fisch	5 sonstige Lebensmittel[1])	6 Gesamt[2])	
8 Kahl	<0,01	<0,05	<0,01	<0,05	<0,01
9 Gundremmingen	<0,04	<0,6	<0,1	<0,8	<0,07
10 Lingen	<0,01	<0,05	<0,01	<0,06	<0,01
11 Obrigheim	<0,03	<1,2	<0,1	<1,4	<0,06
12 Stade	<0,01	<0,01	<0,01	<0,01	<0,01
13 Würgassen	<0,01	<0,04	<0,01	<0,06	<0,01
14 Biblis A	<0,01	<0,01	<0,01	<0,01	<0,01

15 [1]) Milch, Fleisch und pflanzliche Produkte
16 [2]) einschließlich Baden, Bootfahren und Aufenthalt am Ufer

Key:
1. Nuclear power plant
2. Maximum radiation exposure of the entire body (mrem/yr) for an individual person through
3. Drinking water
4. Fish
5. Other food
6. Total
7. Average radiation exposure (mrem/yr) of the population (total body), total
8. Kahl
9. Gundremmingen
10. Lingen
11. Obrigeheim
12. Stade
13. Würgassen
14. Biblis A
15. Milk, meat and vegetable products
16. Including bathing, sailing and exposure while on the banks

Table 9. Annual Emissions from a 1,500-ton UO_2/yr Reprocessing Center

1 Isotop	2 $T_{1/2}$ [Jahr]	3 Jährliche Emission mit Abluft [Ci/Jahr]
H-3	12,3	$3 \cdot 10^{6}$
Kr-85	10,7	$8 \cdot 10^{5}$
C-14	$5{,}37 \cdot 10^{3}$	$9 \cdot 10^{2}$
J-129	$1{,}7 \cdot 10^{7}$	$4 \cdot 10^{-1}$
Sr-90	28,1	$3 \cdot 10^{-1}$
Co-60	5,2	—
Ru-106	1,0	$5 \cdot 10^{5}$
Cs-134	2,05	$2 \cdot 10^{5}$
Cs-137	30,0	$1 \cdot 10^{5}$
Pu-241	14,9	$1 \cdot 10^{-1}$
4 Andere Pu-Isotope		$6 \cdot 10^{-3}$
5 Andere Trans-Uran-Nuklide		$1 \cdot 10^{-1}$

6 Randbedingungen:
7 [1]) WA mit 1500 t UO_2/Jahr entspricht der Kapazität für 50 GWe-LWR.
8 [2]) WA-Emissionen auf der Grundlage heutiger Betriebspraxis, Rückhaltung von Kr-85, H-3, J-129 etc. wird mit verbessertem Grad möglich sein.

Key:
1. Isotope
2. Year
3. Annual emission with exhaust [Ci/year]
4. Other Pu-isotopes
5. Other trans-uranium nuclides
6. Boundary conditions
7. Reprocessing center using 1,500-t UO_2/yr corresponds to a capacity of 50 GWe light water reactor
8. Reprocessing center emissions based on present operating practice, retention of Kr-85, H-3, I-129 etc. could be improved

Table 10. Global Dose Commitments from Various Radiation Sources (UNSCEAR)

Source of exposure	Global dose commitment (days[*])
One-year exposure to natural sources	365
One-year of commercial air travel	0.4
Use of one-year's production of phosphate fertilizers at the present production rate	0.04
One-year global production of electric energy by coal-fired power plants at the present global installed capacity [10^5 MW (e)]	0.02
One-year exposure to radiation-emitting consumer products	3
One-year production of nuclear power at the present global installed capacity [$8 \cdot 10^4$ MW(e)]	0.8
One-year of nuclear explosions averaged over the period 1951–1976	30
One-year's use of radiation in medical diagnosis	70

*) The global dose commitment is expressed as the duration of exposure of the world population to natural radiation which would cause the same dose commitment. The occupational contribution is included.

Table 11. Average Doses due to Emission of Kr-85, H-3, C-14-I-129 (EEC)

1 Jahr		2 Inkorporation	3 Extern	4 Gesamt
				mrem/a
1985	A	0,018	0,001	0,019
2000		0,073	0,004	0,077
1985	B	0,003	0,002	0,005
2000		0,022	0,014	0,036

5 A Mittlere Dosis für eine regionale Bevölkerungsgruppe innerhalb 1000 km Umkreis der betrachteten Wiederaufarbeitungsanlage (Luftpfad).
6 B Mittlere Dosis für die gesamte Bevölkerung der EG durch globale Schadstoff-Zirkulation.

Key:
1. Year
2. Incorporation
3. External
4. Total
5. Average dosage for a regional population group within a 1,000-km radius of the particular reprocessing center (air route).
6. Average dosage for the entire population of the EEC due to global pollutant circulation.

In summary, for large nuclear centers (nuclear power plants and reprocessing centers), we can say that they add a maximum of only 1 percent (on the average, less than 1/10 of 1 percent) to natural radiation. This is in contrast to large coal power plants whose SO_2 immissions nearly double the natural pollution level.

3.2 Long-term Immissions from Nuclear Power Plants

The justifiable question of what longer-term environmental pollution should be expected from the continued construction of nuclear power plants is connected with the long half-life values of several radionuclides,

namely Tritium, Kr-85, C-14 and I-129. Although we can refer to the potential accumulation of these nuclides in the biosphere, on the other hand, we should also point out the natural radionuclides which have existed for millions of years in the global pollution cycles. Nine radioactive trace substances (e.g. Ni, Pb etc) have basically "infinite" half-life values. So if we were to use natural pollution as a reference quantity, then long-half-life values of the emitted radionuclides is not a basically new aspect. The consideration of global pollution cycles is new but this is an intensively studied subject in the area of non-nuclear environmental research.

Studies on radiation pollution through long-lived radionuclides should therefore always be performed on a global scale. Regional or national considerations provide only partial answers. In a report[12] of the UN Committee on Radiation (abbreviated UNSCEAR), the "global dose commitments" of the various radiation sources are compared, whereby this quantity is expressed as an exposure duration at the same dose commitment as natural radiation (Table 10). This concept calculates the theoretical total radiation burden due to a radiation source "k" for the particular population for all time periods according to the equations:

$$S_k = \int_0^\infty \dot{S}_k(t)\,dt$$

with:

$$\dot{S}_k = \Sigma_j \bar{D}_{k,j} N_j$$

We have:

S_k = collective dose commitment
$D_{k,j}$ = personal dose commitment of source "k" and group "j"
N_j = number of persons in group "j"

However, this only provides a basis of comparison of different emission sources over long time periods. However, it is interesting that the dose commitment for global air traffic is comparable from nuclear energy. In the form of the individual dosage, Kelly, Bryant and others[13] have calculated the expected dosage for the year 1985 or 2000 for the named nuclides for the European community. Direct radiation and radiation due to global cycles are considered separately (Table 11). The calculations were performed using a power plant capacity of about 700 GWe for the year 2000 with very low retention factors of 99 percent for I-129, 75 percent for Tritium and complete liberation of Kr-85 and C-14. Nevertheless, they led only to a radiation stress of around 0.1 percent of the natural radiation and 0.05 percent of the limit value of the International Radiation Protection Commission for Genetic Radiation. In reality, these values would be lower since better retention factors will be possible by that time.

4. Comparison of Atmospheric Pollution due to Coal and Nuclear Power Plants

Comparisons of atmospheric pollution arising from coal and nuclear power plants can be made in three different ways.

First, by calculation of the relative pollutant concentration based on an annual pollutant balance using a cell model.[14] There results a ratio of about 1:100 in favor of nuclear energy if we use the present state of retention technology for noble gases (RF = 99 percent for I=129, and for flue gas scrubbing = 80 percent for SO_2) (Table 12).

Table 12: Comparison of Coal with Nuclear Energy

2 Relative Schadstoffbelastung[1]), wenn die gesamte Stromerzeugung der Bundesrepublik durch	
3 – Kohle-Kraftwerke mit 2,75 kg SO_2/h MW (Teilentschwefelung des Rauchgases)	$S_1 = 1,8$
4 oder durch	
5 – LWR-Kraftwerke einschl. Wiederaufarbeitung (Abgasreinigung 99%) erfolgen würde	$S_1 = 0,007$
6 Gesamt-Verdünnungsvolumen, um die jährlichen Schadstoffemissionen auf zulässige Konzentrationen zu verdünnen	7 (m^3/Jahr)
8 – Kohle-Kraftwerk 600 MWe; 2,75 kg SO_2/MWh	$\dot{V} = 1,8 \cdot 10^{14}$
9 – LWR-Kraftwerke 600 MWe; SWR 10	$\dot{V} = 7,4 \cdot 10^{10}$

1 [1]) nach dem Zellenmodell

Key:

1. According to the cells model
2. Relative pollution of the entire electricity generation of the FRG occurred through
3. Coal power plants with 2.75 kg SO_2/h MW (Partial sulfur removal from flue gas)
4. Or by
5. Light water reactor power plants (including reprocessing) exhaust purification: 99 percent).
6. Total dilution volume required to dilute the annual pollutant emissions to permissible concentrations
7. Year
8. Coal power plant
9. Light water reactor power plant
10. Boiling water reactor.

Second, the dilution volume can be calculated. This is the volume needed if the annual emitted pollution quantity from a standard power plant was to be diluted with pure air to the limit value established by the "air" technical committee of the Federal Immission Protection Law or of the Nuclear Power Law. There results a ratio of about 1:1,000 in favor of nuclear energy in this case (Table 12).

Third, the ratio of immissions from individual power plants to the natural pollutant level or natural radiation amounts can be calculated. It turns out that coal power plants approximately double the natural SO_2 level, whereas nuclear power plants cause only a few percent of the natural radiation level. We readily admit that the natural pollution level is no measure for a health hazard so that in this comparison, the effects of the pollutants are not considered.

Comparisons of pollution levels in water have not been performed since fossil-fired power plants contribute no significant amounts to this pollution. Only the generation, processing and transport of fossil fuel will cause such pollution. On the other hand, the pollution of surface water due to nuclear power plants is absolute and is small relative to the pollution already existing (See Table 8).

5. Waste Heat

We mention again that waste heat (usually also called thermal waste or thermal loss occurs independently of the energy carrier for every type of energy conversion. The quantitites of waste heat to be disposed of occur everywhere that primary energy (or useful energy) is converted, i.e., not only in power plants. In order to illustrate waste heat somewhat more clearly, it has become customary to speak of primary waste heat (occurring in the conversion sector, interpretation: power plants and refineries) and of secondary waste heat (that occurring in the final consumption sector). Both wastes affect the atmosphere and the surface waters to some extent.

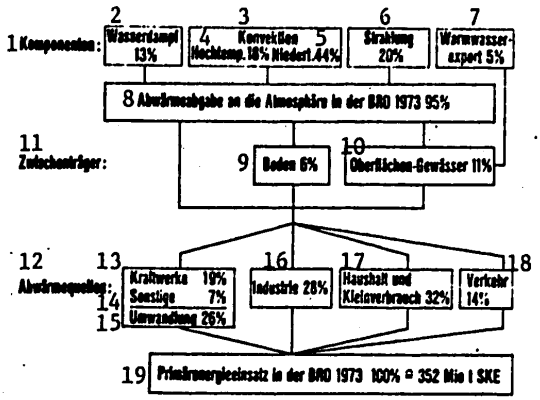

Figure 2. Waste heat Balance of the FRG in 1973.

Key:

1. Components
2. Water vapor
3. Convection
4. High temperature
5. Low temperature
6. Radiation
7. Warm water export
8. Waste heat released to the atmosphere in the FRG, 1973
9. Soils
10. Surface water
11. Intermediate carriers
12. Waste heat sources
13. Power plants
14. Other
15. Conversion
16. Industry
17. Household and small consumers
18. Traffic
19. Primary energy use in the FRG, 1973

In addition, emission of some pollutants occuring during conversion of fossil fuels (in particular CO_2) has an indirect warming effect on the atmosphere as a result in the natural radiation balance. But let us discuss direct waste heat which is composed of primary and secondary waste heat.

In Figure 2, we see the waste heat balance of the FRG for the year 1973.

Two facts should be pointed out:

1. The amount of primary waste heats from power plants of the total waste heat is about one-fifth. A disadvantage, however, is that this amount of heat occurs in a concentrated area. In addition, it is generally constant throughout the year and is difficult to reduce for a short time.

2. The amount of secondary waste heat from the spheres of industry, households and traffic amounts to about 75 percent of the total waste heat. This percentage is emitted over a large area. It fluctuates during the year (space heating) and could be more easily reduced by specific measures.

The greatest part of the total waste heat passes directly into the atmosphere (and only to a minor extent into the ground and surface water). Although the amount of heat absorbed by waters is only 11 percent, pollution limits in this regard have appeared now for the first time.

5.1 Surface Water Pollution through Waste Heat

The thermal pollution of surface water occurs predominantly through primary waste heat from power plants. At the end of the 1960's, it was discovered that there are limits, i.e., that primary waste heat could not be stored in surface waters for the long term under consideration of the growing energy consumption. Scientifically established temperature values did not exist, but on the other hand, they were needed for future planning. As a guideline value, we adopted ΔT_{max} = 3K and T_{max} = 28°C. in surface water (initially for the Rhine River only, then later for other rivers with minor variations). Initial estimations using these boundary values showed that the cooling ability of German surface water is at 90 GW thermal power, and that this value would probably be attained by the mid-1980's. This interaction led to increasing demands for the use of wet cooling towers particularly in new power plants.

In the meantime, the question of surface water pollution by power plants was studied in detail. Particularly in the United States it was noticed that in clean surface waters, warming of 3°K is not an upper limit; indeed, certain species of fish sought the warm water current at temperatures up to 30°C. provided sufficient refuges remained to them. In additon, experience was gained on German rivers where no recognizable damage to water fauna was noted (e.g., in the heat-wave period of 1976 with water temperatures up to 30°C. Previous episodes of extensive fish fatality were

always attributable to chemical pollution of water. In a few cases, it was even determined that for chemical prepollution in water, introduction of cool water resulted in a limited improvement of water quality, since the addition is normally connected with a significant introduction of oxygen. The question of valid temperature values today for waste heat introduction has thus become more complicated and it is hoped that a revision of older guidelines will soon occur.

The question of temperature limits in water can also be viewed against the background of national total energy savings. For large power plants, the transition from flow-cooling to wet-cooling towers means:

--an increase in electricity generation costs;
--a loss of useful energy (electricity) at the same consumption of primary energy; and
--(last but not least) an increase in waste heat occurring for the same consumption of primary energy.

In the worst case, the net efficiency of a large power plant would be reduced by 3 percent if we had to switch from flow-cooling to wet-cooling towers. This corresponds to a loss of about 10 percent of useful energy for the particular system. Estimates indicate for complete conversion of all power plants to wet-cooling-tower operation, the total necessary power plant output would have to be increased by 7 percent. At an installed output in the FRG of about 84 GW, this would correspond to about 6 GW or about 5 large power plants like the Biblis A plant. In other words: a sudden transition from flow-cooling using fresh water to wet-cooling towers should not occur. An optimum cooling system should be implemented on a regional basis with regard to the available surface waters and cooling towers should only be used (primarily as run-off cooling towers) where surface water conditions require.

The catchword "dynamic cooling management" is appropriate here, i.e., the application of methods for distribution of cooling capacities for different power plants on the same river which is more oriented toward hydrological and meteorological conditions than to statistic distributions and national boundaries. Even optimum cooling management can decrease the amount of waste heat and thus help save energy.

5.2 Waste Heat Effects on the Atmosphere

The primary waste heat burden concerns the atmosphere. The waste heat equation presented above illustrates in particular that the amount emitted through cooling towers is small when considered on a regional basis. It amounts to about one-tenth of the total waste heat for the entire FRG. The effects of individual large wet-cooling towers are presently determined by extensive measuring models and calculation.[15, 16] The previously feared harmful effects like increased fog formation, reduced sunshine, heavy rainfall, bacteriological effects, etc. have proven to be insignificant.

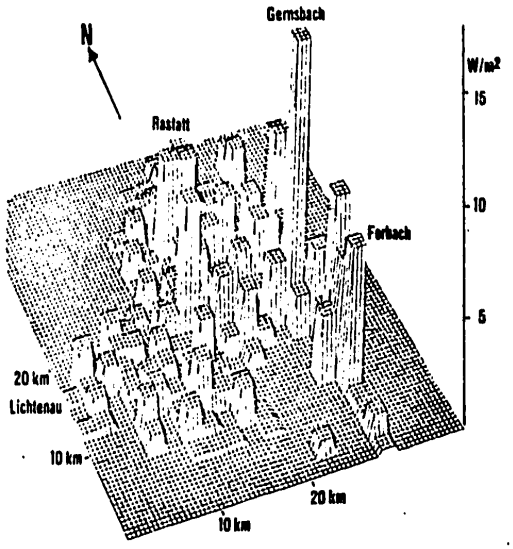

Figure 3. Total Waste Heat Emission in 1973 in the Rastatt District and in Baden-Baden

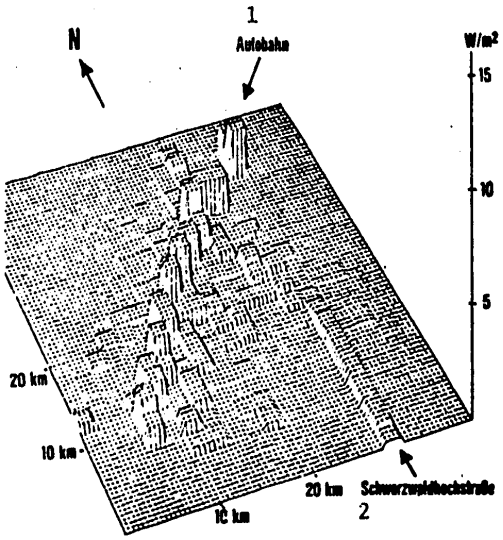

Figure 4: Waste Heat Emission in 1973 (Highway Traffic) in the Rastatt District and in Baden-Baden.

Key: 1. Freeway
2. Highway in Black Forest

The situation with secondary waste heat is different. In particular, studies performed within the framework of the waste heat project of the upper Rhine region promoted by the Federal Environmental Office have shown that the contribution of industry, households, and traffic can have a significant affect on the local climate. Figures 3 and 4 show typical "waste heat peaks," in W/m^2 as they occur on an annual average. Peak values of up to 30 W/m^2 are attained.

Table 13: Waste Heat Tower and Performance Density of Typical Polluter

1 Emittent	2 Abwärmeabgabe pro Jahr (gesamt) tSKE/a	3 Hauptemissionsfläche m^2	4 Leistungsdichte der an die Luft abgegebenen Wärme W/m^2
5 Naßkühlturm eines KKW mit 1000 MWe (Kreislaufbetrieb)	1 800 000	20 000	84 000
6 Raffinerie (Prozeßanlagen) mit einem Durchsatz von 5–6 Mio t Rohöl/a	400 000	100 000	4 000
7 Zellstoff- u. Papierfabrik mit 70000 t Zellstoff- und 130000 t Papier-Produktion/a	160 000	50 000	2 000
8 Zementfabrik mit einer Jahresproduktion von 800000 t	48 000	80 000	600
9 1 km-Abschnitt des Oberrheins bei 1 K Erwärmung über Gleichgewichtstemperatur	5 000	200 000	23
10 1 km-Autobahnabschnitt bei tägl Verkehrsmenge von 30000 Pkw und 7000 Lkw	2 500	50 000	46
11 1 km-Bundesbahn-Hauptstrecke bei 200 Zügen/d und 95% E-Traktion	140	10 000	12
12 1 km^2 im Zentrum einer Großstadt	32 000	1 000 000	30
13 Einfamilienhaushalt (4 Personenhaushalt)	6	400	14

Key:

1. Emitter
2. Waste heat output per annum (total) tSKE/year
3. Primary emission surface area
4. Power density of the heat given to the air (W/m^2)
5. Wet-cooling tower of a nuclear power plant of 1,000 MWe (cycle operation)
6. Refinery processing systems (with a throughput of 5-6 million tons of crude oil per year)
7. Cellulose and paper manufacturing of 70,000 tons cellulose and 130,000 tons of paper products per year
8. Cement factory having an annual production of 800,000 tons
9. 1 km section of the upper Rhine River for a 1 K warming above equilibrium temperature
10. 1 km freeway section with a daily traffic load of 30,000 passenger vehicles and 7,000 trucks
11. 1 km main railroad line carrying 200 trains per day and 95 percent electric engines
12. 1 km^2 in the center of a large city
13. Single family dwelling (4-person household)

Although these values attain 20-30 percent of the natural solar radiation, their influence on the weather would still be small. More accurate information will only be available after the developmental diffusion models are available on a mesoscale. This subject is being emphasized by the upper Rhine region waste heat project jointly with the extensive measurements performed by the weather service. Table 13 presented an interesting result by comparing waste heat emitters. It shows the magnitude of waste heat emissions from energy-intensive operations, but also for traffic.

5.3 CO_2 and Climate

In conclusion, we present a brief discussion of the "indirect waste heat" or more accurately, the CO_2 effect. Studies on this subject have been going on for a long time. Even in the 1960's, larger conferences were dedicated to this subject. What is the status today?

1. It is known that the CO_2 content of the atmosphere is constantly increasing. The preindustrial level of about 292 ppm has grown today to about 330 ppm. Continuous monitoring has been performed since 1958. The rate of growth is at present about 1 ppm/year.

2. The question of how the atmosphere reacts to the increase in CO_2, that is, by warming up due to increased absorption of long-wave radiation or by cooling due to regeneration effects with the other components of the atmosphere (especially aerosols and water vapor), can be considered solved today in accordance with the status of modeling. A warming trend will be the result.

3. The size of the postulated temperature increase is still under discussion. It is said that a doubling of the CO_2 content will cause a global average temperature increase of about 2 K. Several authors indicate even greater values. The temperature increase which has occurred today is caluclated as 0.4 K, but this value is still in the range of natural fluctuations in average atmospheric temperature.

4. CO_2 is a constituent of the global carbon cycle. Within this cycle there are certain unknown quantities. This is important for the question of determining the amount of CO_2 which will disappear over the long term in the ocean and sediment reservoirs (Figure 5).

5. CO_2 has a long residence time in the atmosphere. The decay time for CO_2 concentration increases amounts to several hundred years. Limiting the consumption rate of fossil fuels worldwide would not have an effect for the short term. Nevertheless, this would provide the best opportunities for counteracting the problem. According to calculations by Zimen,[17] a doubling of CO_2 concentrations over the preindustrial level would occur by about the year 2030 at the present growth rate in the consumption of fossil fuels of 3.5 percent/year. However, we should note that other air

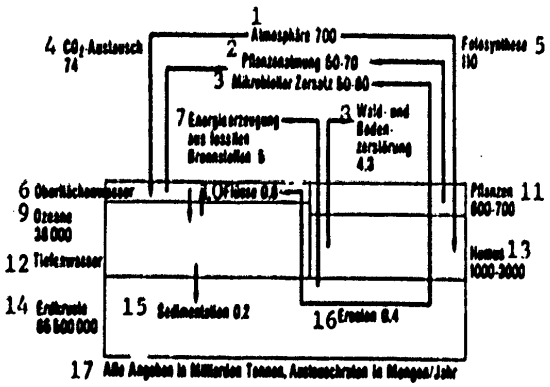

Figure 5: Carbon Cycle

Key:

1. Atmosphere
2. Plant respiration
3. Microbial decomposition
4. Photosynthesis
5. CO_2-exchange
6. Surface water
7. Energy generation from fossil fuel
8. Forest and soil disruption
9. Oceans
10. Rivers
11. Plants
12. Deep water
13. Humus
14. Earth crust
15. Sedimentation
16. Erosion
17. All figures are expressed in billion tons, exchange rates in quantity/year

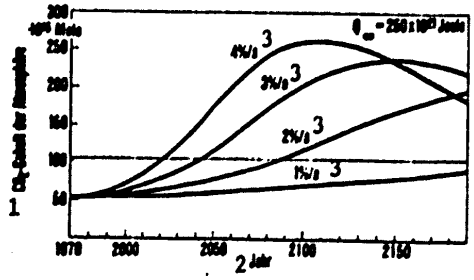

Figure 6: CO_2-Emission for Four Alternative Growth Rates of Energy Consumption Source: Zimen et al.

Key:

1. CO_2 content of the atmosphere
2. Year
3. Year

components like nitrogen oxides, fluorine-chlorine-hydrocarbons, etc., could have the same effect as CO_2 so that this doubling might occur even earlier. In addition to limiting the consumption of fossil fuels worldwide, the large area destruction of forests (particularly in the tropics) must be stopped since considerable quantities of CO_2 are fixed there by photosynthesis (Figure 6).

6. Regarding the question of the effects of a temperature increase, there are still large uncertainties; 2-3 degrees is a lot, if we consider that a drop of 5 degrees caused the last ice age 10,000 years ago. The following effects are discussed:

Because of the warmer surface layers of the oceans, the ocean level would rise thus preventing deep water exchange. This would accelerate the CO_2 increase since then less CO_2 would be transferred to the sediments. In addition, the climate zones and agricultural conditions would shift to the north. In addition, rainfall zones would shift with attendant consequences on drinking-water supply. The deserts would increase in size. Atmospheric purification processes for pollutants which are connected with water vapor, would be regionally disturbed.

7. Of course, a quantitative explanation of the CO_2 effects is still incomplete. The question of the interaction between the CO_2 increase and the consumption of fossil fuels and the resulting temperature increase in the atmosphere should be considered to be basically clarified.

6. Conclusion

While preparing this report, I received extensive support from a number of colleagues from the research center at Karlsruhe, from Bergbauforschug, Kraftwerk-Union, the petroleum industry which provided data and information. I wish to express my sincere gratitude at this point.

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WEST GERMANY

CHEMICAL POLLUTION, SAFETY IN FRG DISCUSSED

Frankfurt/Main FRANKFURTER ALLGEMEINE in German 14 Nov 78 p 1

[Article by Rainer Ploehl: "The Risk in Chemistry"]

[Text] Chemistry cannot be conducted without risk, whether in the laboratory or on an industrial scale. Along with many more or less harmless accidents in chemical plants there have been serious disasters again and again. In 1974 in Flixborough, England, a whole plant blew apart in a frightful explosion. In 1976 in Seveso and Manfredonia occurred two accidents which were unusual due to the scale of their devastating effects. Poisonous chemicals which entered human bodies during production, or later from the polluted environment, have unleashed a series of catastrophes which caused sensations.

The horrible events of the past have given rise to serious doubts as to the security of chemistry and its products. These fears are not unjustified; some risks of chemistry are already fully known to us. On the other hand, experience has also shown that industrial chemistry has already reached an extraordinarily high level of safety. Serious incidents are rare, measured against the huge production capacities. This can be demonstrated in the case of chlorine gas, one of the most important bases of chemical syntheses. Chlorine, as the adversaries of chemistry point out, is one of the most dangerous products. Nevertheless chlorine gas escapes have caused no deaths in the FRG in the last 25 years. Comparing the risks of the still young nuclear technology with a chemical industry resting on 100 years of practice is demagogic.

The surprisingly high reliabilty of the technology of chemical processes in the face of the danger of chemical substances and reactions is the result of comprehensive security measures. Profitability and safety are closely linked for the chemical industry. Only safe installations are fully usable and therefore profitable. Finally, trade regulations and innumerable other legal ordinances also protect us from harmful effects of chemical technology. All dangerous installations require examination

and approval of the regulatory bodies. The fact that all chemical installations rated as especially dangerous conform to all requirements in the FRG was shown recently in a systematic examination ordered by the North Rhine Westphalian state government. In the checks of 140 chemical plants no serious technical defects could be established.

Despite this on the whole favorable situation, the safety of chemical plants can doubtless be improved further. The causes of accidents, which of course can become catastrophes, seldom lie in unforseen, thus far unknown, chemical reactions. What may occur in the transformation of particular compounds is not only researched with refined experiments and tests in the laboratory today, but also theoretically, with computers. Man and technology fail much more often. In four out of five cases, man is the guilty factor in an accident in the chemical industry. Only in one out of five cases is chemical technology responsible. The safety of chemical plants can, therefore, be improved through the thorough establishment of and adherence to installation and operating regulations. This means that precise work regulations for the individual job and appropriate instruction of personnel are imperative.

Surveillance according to the accident ordinance just now being worked out in the Federal Interior Ministry applies here, too. It concentrates on plants in which especially poisonous substances are produced or may develop. A total of about 100 compounds are to be affected by the accident ordinance, which in addition to alarm and catastrophe plans, also provides for regulations for the transportation of such chemicals--at present the most dangerous area of chemistry.

The greatest risks are related not to the production of, but to contract with, toxic materials. Many chemicals endanger us through direct contact, while others get into the ecological cycle where they develop their poisonous effect. Whereas in the past attention was paid mainly to acutely manifested damage, it is increasingly often a matter of trouble appearing years later, or, as in the case of carcinogenic substances, even after decades.

Awareness of this has not been without consequences. Newly synthesized substances must in the future be toxicologically tested and authorized on a global scale, like drugs, before they get into the environment in larger quantities. It is nevertheless extremely difficult to assess the harmful potential of a substance and to weigh damage against utility. An appropriate chemical law is also being prepared in the FRG. However there will be considerable debate internationally over the scale of the studies, which can cost up to 2 million marks for one substance, due to the possible distortions of competition.

The risks in chemistry are today assessable, moderate on the whole, and therefore tolerable. It is a question now of not letting public discussion of safety in chemistry be diverted into the irrational. Chemistry, which most citizens equate with dark alchemy, could be as easily crippled as nuclear technology--with fatal economic consequences.

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WEST GERMANY

VULNERABILITY OF FRG COAST TO OIL SPILL REPORTED

Frankfurt/Main FRANKFURTER ALLGEMEINE in German 3 Nov 78 p 8

[Text] Bremerhaven, 2 November (dpa). The Federal Republic of Germany is not equipped for a large-scale oil spill on its coast; a maximum of three research groups are working primarily on the subject of "Oil in the sea." There is a lack of background information on endangered regions. The methods even for a rough estimate of the effect of the oil on marine organisms are not perfected; there are many gaps in the field of bacteriology; little is known to date about the effect of oil on the mud flats. So said the head of the Institute for Marine Research in Bremerhaven, Prof Sebastian Gerlach, to the ministers and senators of the four north German coastal states responsible for environmental protection. The scientist also added that there is a lack of effective oil removal equipment which could be used in the currents of the tidal area. Still undecided, moreover, is the scientific dispute over the question of whether the chemicals used to combat the oil are not perhaps more dangerous for fauna and flora in the sea than the spilled oil.

In the opinion of Gerlach international cooperation in these questions is possible. He, as chairman of the working group of German marine research in the study of oil spills, points out that for example the United States, Canada and Great Britain have already started comprehensive research and control operations, while countries like Denmark, Belgium, or the Netherlands up to now have been as rather inactive as the Federal Republic.

Greater efforts seem imperative to the scientist. At the present time one research group in the mud flats of the Jade is taking oil from the ground up and studying the consequences. Unanswered till now is the question of how deeply oil sinks into the sediment of the mud flats and how long it has an effect there.

In Gerlach's view, a marine science consultative organ must be appointed which in emergencies could best inform the competent head action offices on the position of science. An intervention reserve must also be created, from which previously agreed research operations could be financed without delay in the case of an oil spill.

German marine research regards the promotion of study projects concerning oil in the sea, the biological effect of countermeasures, and the expansion of the necessary research capacity for this as equally important. Finally the compilation of a series of maps of the German coast is demanded as an immediate measure; it should give indications of sensitive areas and contain all details important to an oil spill such as hydrographic conditions, bird sanctuaries, aquacultures or salt meadows.

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